CHAPTER 5

NOISE SURVEYS

1. **GENERAL**. This chapter provides the basic information necessary to evaluate and document employee noise exposure and to assist with determining compliance with Navy noise instructions. For more detailed information, see references 5-1, 5-2, and 5-3.

Noise survey and dosimetry forms are provided in Appendix 5-A.

2. **DEFINITIONS**.

a. Crest factor. The arithmetic difference between the peak sound pressure level and the root-mean-square (RMS) sound pressure level for a given noise measurement situation. The crest factor characterizes a sound measuring instrument's ability to accurately measure transient or impulse sound levels. Instruments should have a crest factor capability adequate to handle the noise waveform.

b. Criterion level. The continuous equivalent A-weighted sound level which constitutes 100 percent of an allowable exposure. For Navy purposes, this is 84 dB(A) for 8 hours in a 24-hour period. The dosimeter readout can be used to calculate both the continuous equivalent A-weighted sound level (L_A) and the 8-hour time-weighted average (TWA) for the time period sampled, using the following equations:

$$L_A = 84 + \left[13.3 \times \log\left(\frac{D}{12.5 \times T} \right) \right]$$

Equation 5-1

$$TWA = 84 + \left[13.3 \times \log\left(\frac{D}{100} \right) \right]$$

Equation 5-2

Where:

L_A = continuous equivalent A-weighted sound pressure level, in decibels, for the time period sampled, if the

Criterion Level is 84 dB(A) for 8 hours exposure and the Exchange Rate is 4 dB

D = dosimeter read-out in percent noise dose

T = sampling time in hours

c. Decibel (dB). The unit of measurement for sound pressure level. The sound pressure level, in dB, is equal to 20 times the common logarithm of the ratio of the existing sound pressure to a reference sound pressure of 20 micropascals.

d. Decibel, A-weighted (dB(A)). Overall sound pressure level where the intensity contribution from each frequency is not equal but is adjusted (i.e., weighted) according to the values in Reference 5-4.

e. Dosimeter threshold level. Threshold level is the A-weighted sound pressure level at which a noise dosimeter begins to integrate the noise into the measured exposure. For Navy purposes this is 80 dB(A).

f. Exchange rate. The exchange rate is a trade-off between the sound level in decibels and the duration of exposure in hours. The Navy exchange rate is 4 dB. Each 4 dB increase in sound level (above the 84 dB(A) 8-hour permissible exposure limit) can be balanced by a 50% reduction in unprotected exposure duration.

g. Impact noise. Noise produced by a single collision of one mass in motion with a second mass, generally of less than 0.5 second in duration and which repeats no more than once per second.

h. Impulse noise. Impulse noises are usually considered to be singular noise pulses, each less than one second in duration, or repetitive noise pulses occurring at greater than 1 second intervals. Also defined as a change of sound pressure of 40 dB or more within 0.5 second.

i. Meter response. The motion of the sound level meter's needle (or other output) resulting from an excitation (stimulus). To allow the user to follow the movement of the indicating needle, "slow" and "fast" averaging circuits are built into the sound level meter. In practical terms, the "slow" circuit allows visual tracking of the "average" sound pressure level and the "fast" circuit allows visual tracking of the "variability" of the sound pressure level. Sound level meters should usually be set for "slow" response, which has an exponential time averaging constant of 1,000 milliseconds. Type 0, 1, and 2 sound level meters are also equipped with a "fast" response setting which has an exponential time averaging constant of 125 milliseconds. Some sound level meters are equipped with an "impulse" response setting which has an exponential rise time averaging constant of 35 milliseconds. The "impulse" setting also has a decay constant of 1,500 milliseconds which is sufficiently slow to allow a user to manually record the maximum reading before it disappears from the display. The "impulse" setting is not sufficiently fast to measure true "peak" sound pressure levels due to "impulse" or "impact" noise.

j. Noise. An undesired sound; may be either intermittent or continuous.

k. Peak sound pressure level. The maximum instantaneous sound pressure level that occurs during a specified time interval. The "peak" detector in Type 0 sound level meters provides acceptable measurements of 50 microsecond duration impulse/impact noise and in Type 1 and 2 sound level meters for 100 microsecond duration impulse/impact noise.

l. Rise time. The time required for a sound to reach its maximum level during a stated time period.

m. Root mean square (RMS). Square root of the arithmetic mean of the squares of a set of instantaneous amplitudes, or a set of values of a function of time or other variable.

n. Sound level meter (SLM). An instrument used to measure sound pressure levels which meets the requirements of Reference 5-4.

o. Sound pressure level (SPL). The root-mean-square value of the pressure changes above and below atmospheric pressure when used to measure steady state noise.

3. **NOISE MEASUREMENTS**. Noise measurements will be taken by industrial hygienists, audiologists, industrial hygiene technicians, workplace monitors or others suitably trained. An industrial hygienist is responsible for making noise exposure assessments and designating noise hazardous areas based on noise measurements and associated information as part of industrial hygiene surveillance programs.

a. Instruments. Sound level meters and noise dosimeters are used to assess an employee's exposure to noise. Octave band analyzers are used to identify the frequencies at which the noise is generated and are mainly used to aid in selecting engineering controls.

(1) Sound level meters (SLM). All sound level meters used by the Navy will conform, as a minimum, to the Type 2 requirements cited in reference 5-4, which sets performance and accuracy tolerances. The sound level meter will be electroacoustically calibrated and certified annually. An acoustical calibrator, accurate to within one decibel, will be used to calibrate the instrument before each survey and to revalidate the calibration at the conclusion of the survey. Acoustical calibrators will be electroacoustically calibrated and certified annually. See Chapter 8, Industrial Hygiene Equipment Maintenance and Calibration for specifics on calibrating all noise measuring instruments.

(a) Types of SOUND LEVEL Meters:

(i) Type 0: Laboratory standard. Used as a high precision reference in the laboratory; not intended for field use.

(ii) Type 1: Precision sound level meter. Can be used in the field and laboratory.

(iii) Type 2: General purpose sound level meter. Designed to have less stringent tolerances than Type 1; used for field measurements.

(iv) Type 3: This was a type of survey instrument listed in the 1971 version of Reference 5-4. It is mentioned here since some of these soundlevel meters may still be in use. Their accuracy was less than the Type 2 and they were, therefore, not acceptable for Navy industrial hygiene noise measurements. This type meter was dropped from the ANSI standard in 1983.

(v) Type S: These sound level meters may have some but not all of the features required of a specified type. They are not generally acceptable for Navy industrial hygiene work.

(b) Continuous or intermittent noise will be measured in dB(A) with a sound level meter set for slow response.

(i) The A-weighting scale approximates the ear's response for sound levels below about 55 dB and discriminates against energy in the low frequency ranges just as the ear does.

(ii) The C-weighting scale approximates the ear's response for sound levels above 85 dB and may be used to evaluate hearing protective device effectiveness. It responds with little discrimination against low frequencies, detects more energy, and may result in higher readings than the A scale. C-weighted sound level measurements should be taken and used to determine hearing protector performance.

(c) Impact or impulse noise will be measured as dB peak sound levels with sound level meters which have an impulse or peak hold circuit, a rise time constant not exceeding 35 milliseconds, and the capability to measure peak sound levels up to 140 decibels, inclusive (peak).

(2) Noise dosimeters. Specifications for noise dosimeters are provided in Reference 5-5. For Navy use, the dosimeter must meet, as a minimum, class 2A-84/80-4 where:

(a) "2" means that the dosimeter has tolerances that correspond to those for a Type 2 sound level meter (reference 5-4).

(b) "A" means the A-frequency weighting network,

(c) "84" means a 84 decibel slow criterion level,

(d) "80" means a 80 decibel threshold level, and

(e) "4" means a 4 decibel exchange rate.

Additionally, dosimeters shall be capable of accurately measuring impulse noise between 80 dB(A) and 130 dB(A) (i.e., have a crest factor of at least 50 dB) and integrating it into the daily noise dose.

Although not required, a datalogging capability which will allow collection of time history data is recommended when dosimetry results will be used to devise noise control strategies. The ability to field select different criterion levels and exchange rates is also desirable but not required.

(3) Octave band analyzers (OBA). OBAs are used to determine where sound energy lies in the frequency spectrum. This is important for recommending engineering controls for noise. Always follow the manufacturer's instructions when taking OBA readings. These readings usually require several minutes to complete, therefore, the sound being measured must be steady state and of a long enough duration to complete the measurements.

b. Noise measurement records. All noise measurements and pertinent information are documented on NEHC 5100/17, "Industrial Hygiene Noise Survey Form," or NEHC 5100/18, "Industrial Hygiene Noise Dosimetry Form." Reference 5-1 requires that noise measurement records be kept for 40 years after the data is collected. As a minimum, records must include:

(1) Number, type and location of the noise sources;

(2) Number and identification of personnel in the work area and their daily noise exposure and duration (dosimetry only);

(3) Type, model, serial number of test equipment and calibration data;

(4) Location, date, and time of noise measurement;

(5) Noise levels measured and hazard radius (both 84 dB(A) and 104 dB(A)); and

(6) Per Reference 5-6, the 8-hour time-weighted average exposure in dB(A), if the measurements are sufficient to calculate it (e.g., dosimetry data or many sequential measurements over the workshift with a sound level meter).

(7) Name and signature of the person(s) who performed the survey.

4. **SAMPLING PROTOCOL**.

a. Types of surveys.

(1) General survey - conducted to determine the locations and boundaries of hazardous noise areas. This survey is usually done with the Type 2 sound level meter.

(2) Noise control survey - a Type 1 sound level meter with an octave band filter is used to obtain engineering-type data to aid in selecting a course of action for noise control or to certify audiometric testing booths.

(3) Noise dosimeter survey - dosimeters are used to assess individual noise exposure. Noise dosimeters with a datalogging capability may be used to determine which processes during the workshift are the major contributors to noise exposure so noise control efforts can be focused where the most benefit will be derived.

b. Sound level meters. Sound level measurements should be taken following the manufacturer's instructions. For practical purposes, the procedure below should be followed for all sound level measurements:

(1) The sound level meter should be set to slow response. Measurements should be taken using the "A" weighting network.

(2) The microphone should be held in the person's hearing zone and oriented in accordance with the manufacturer's recommendations (i.e., either perpendicular or parallel to the noise source). Select the ear closest to the noise source. Repeated measurements are required during a single day and/or different days of the week to account for the variation in noise levels produced by changes in operation schedules and procedures. Dosimeters are the instruments of choice for monitoring personal noise exposure.

(3) When noise levels measured at each ear for a single individual are different, the higher level should be used for compliance purposes.

(4) Note sound level meter measurements during the different phases of work performed by the employee during the shift, taking enough measurements to identify work cycles. Remember that noise levels will vary during the day and work operation. Sufficient measurements will have to be obtained to determine an actual exposure.

(5) Obtain sound level measurements at the noise source. Record locations of sources on a diagram. Determine the distance from the noise source where the sound level falls to 84 dB(A). Repeat several times and record on the diagram. This is the hazard radius.

c. Noise dosimeters. Always follow the manufacturer's instructions. For practical purposes, the procedure below should be followed for all dosimeter measurements:

(1) The microphone should be in the person's hearing zone (defined as a sphere with a two foot diameter surrounding the head). Considerations of practicality and safety for each survey location will dictate the actual microphone placement.

(2) When the dosimeter is positioned (normally in the shirt pocket or at the waist), clip the microphone to the employee's collar at the top of the shoulder, as close as possible to the employee's ear that is closest to the noise source. Care should be taken to ensure that the microphone is in a vertical position. Placement of ear clips should be in accordance with the manufacturer's instructions.

(3) Position and secure any excess microphone cable to avoid snagging or any inconvenience to the employee. The cable can be taped directly to the employee's outer clothing.

(4) Inform the employee that the dosimeter should not interfere with normal duties, and emphasize that the employee should continue to work in a routine manner.

(5) Explain to each employee being surveyed the purpose of the dosimeter and that it is not a speech recording device.

(6) Instruct the employee being monitored not to remove the dosimeter unless absolutely necessary, and not to cover the microphone with a coat or other garment. Inform the employee when and where the dosimeter will be removed.

(7) Make sure that the dosimeter is in recording mode before starting the survey. The dosimeter should be checked periodically to ensure that the microphone is oriented properly.

(8) Take and record sound level meter measurements during the different phases of work performed by the employee during the shift, taking enough readings to identify work cycles. Sound level meter and dosimeter readings taken during the same shift should be comparable.

(9) For dosimeter results to be meaningful, a log of the employee's activity shall be maintained by the person conducting the survey so that exposure data can later be correlated with different locations and activities, thereby identifying noise sources. **Do not leave the dosimeter unattended in the field.**

5. EFFECTS OF THE ENVIRONMENT ON INSTRUMENT PERFORMANCE.

a. Temperature. Sound measuring equipment should be used within the manufacturer's design specifications. Store sound measuring equipment in accordance with the manufacturer's recommendations.

b. Humidity. Sound measuring instruments perform accurately as long as moisture does not condense or deposit on the microphone.

c. Atmospheric pressure. When checking an acoustical calibrator always apply the corrections for atmospheric pressure and temperature as directed in the manufacturer's instructions.

(1) In general, if the altitude of the measurement site is less than 10,000 feet above sea level, the correction is negligible and need not be considered further.

(2) If the measurement site is at an altitude higher than 10,000 feet above sea level, or if the site is pressurized above

ambient pressure, use the following equation to correct the instrument reading:

$$C = 10 \times \log\left[\sqrt{\frac{460+t}{528}} \times \left(\frac{30}{B}\right)\right]$$

Equation 5-3

Where:

C = correction to be added to the measured sound level (dB)
t = temperature (°F)
B = barometric pressure (inches Hg)

NOTE: For high altitude locations, C will be positive; for hyperbaric conditions, C will be negative.

d. Wind. Wind blowing across a microphone produces turbulence which may cause positive error in the measurement. Use a wind screen for all out-of-doors measurements and where there is significant air movement inside a building (e.g., cooling fans or gusty wind through open windows).

e. Magnetic fields. Devices such as heat sealers, induction furnaces, generators, transformers, electromagnets, arc welders, radars, and radio transmitters generate electromagnetic fields which may induce current in the electronic circuitry of sound level meters and noise dosimeters causing erratic readings. If sound level meters or dosimeters must be used near such devices, attempt to determine if the effect of the magnetic field is significant. Follow the manufacturer's instructions for use around magnetic fields.

6. **EFFECTS OF SOUND ON INSTRUMENT READINGS**.

a. Microphone placement. For sound level meters and noise dosimeters that use omnidirectional microphones, the effects of microphone placement and orientation are negligible in the typical reverberant environment. As a general rule, the sound level meter should be held at arm's length to reduce the body-baffling effect. To minimize body shielding effects on microphones, consult the manufacturer for recommended placement. If the measurement site is non-reverberant and/or the noise source is highly directional, consult the manufacturer for recommended microphone placement and orientation. Also, ensure the microphone is not directed toward reflective surfaces. This would result in higher sound level readings.

b. Impulse noise.

(1) In evaluating impulse noise, determine the crest factor for the noise to be measured. The noise crest factor should be less than the measuring instrument's crest factor capability.

(2) The crest factor of a given sound measurement situation can be determined by first obtaining the peak sound pressure level and the average sound pressure level using an impulse precision sound level meter. The crest factor is determined by subtracting the average sound pressure level from the peak sound pressure level. By true definition, the crest factor is the peak sound pressure level minus the RMS sound pressure level, however, for practical purposes, the RMS and average sound pressure level are the same. Consult the instrument instruction manual if there is difficulty determining the crest factor.

(3) Compare the noise crest factor with the crest factor for the instrument. This information will be found in the specifications section of the manufacturer's literature provided with the instrument.

(4) Audio dosimeters with impact noise capabilities are available. Check with the manufacturer for information as to the applicability to specific situations.

7. **PERMISSIBLE EXPOSURE LEVEL**. The Navy permissible exposure levels for occupational exposure to noise are:

a. 84 dB(A) for 8 hours in a 24-hour period.

b. For periods of less than 16 hours in any 24-hour period, the permissible exposure in dB(A), can be determined from the following equation:

$$dB(A) = 4\left[\frac{\log\left(\frac{16}{T}\right)}{\log 2}\right] + 80$$

Equation 5-4

Where: T = exposure time (hours)

c. For a given sound level, the allowable exposure period follows:

$$T = \frac{16}{2^{[(L-80)/4]}}$$

Equation 5-5

Where,

T = time (hours)
L = sound pressure level (dB(A))

d. When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect must be considered. If the sum of the following expression exceeds one, then the combined exposure exceeds the Navy permissible exposure limit:

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots + \frac{C_n}{T_n}$$

Equation 5-6

Where:

C = total time of exposure at a specified noise level
T = time of exposure permitted at that level

e. 140 dB peak sound pressure level for impact or impulse noise.

8. **HAZARDOUS NOISE AREAS**. The designation of "hazardous noise areas" is based on the following criteria:

a. Any work area where the 8-hour time-weighted average sound pressure level is greater than 84 dB(A);

b. Any work area where the peak sound pressure level (impulse or impact) exceeds 140 dB; and

c. Areas where the sound pressure levels are greater than 84 dB(A) 8-hour TWA, but less than 104 dB(A) 8-hour TWA should be labeled to require single hearing protection (approved ear plugs <u>or</u> circumaural muffs). Areas where the sound pressure levels are 104 dB(A) 8-hour TWA or greater should be labeled to require double hearing protection (approved ear plugs <u>and</u> circumaural muffs).

9. **<u>TYPES OF HEARING PROTECTION</u>**. References 5-1 and 5-2 provide guidance and requirements for hearing protection.

a. Fitted inserts.

(1) Most are elastomeric.

(2) Sized non-disposable insert devices can only be fitted and stocked by trained medical department personnel.

(3) Sizing gauge is useful, but does not take the place of actual fitting.

(4) Are available in various sizes, depending upon the type. Occasionally, a different size must be fitted to each ear.

(5) Attenuation is approximately 20 dB. Noise reduction rating varies by manufacturer and product, and in real world situations is rarely as high as the manufacturer's label.

b. Disposable type inserts.

(1) Moldable, does not require fitting, provides a very good seal if properly inserted, conforms to the shape of the ear canal.

(2) Attenuation is approximately 20 dB. Noise reduction rating varies by manufacturer and product, and may not reach the level measured under laboratory conditions.

c. Circumaural muffs.

(1) Cup-like plastic domes that cover the entire ear, connected by a spring band.

(2) Attenuation varies between manufacturers and products, and is approximately 20-30 dB.

d. Canal caps.

(1) Block the ear canal only

(2) Attenuation is low, typically 12-18 dB. Primary value lies in portability and ease of insertion/removal for intermittent exposures.

> CAUTION: Field evaluations of hearing protective devices suggest the direct use of the manufacturer's published noise reduction ratings will overestimate hearing protector performance. The Occupational Safety and Health Administration has instructed field compliance inspectors to derate the noise reduction rating by 50%. When applying noise reduction ratings (NRRs) to measured sound pressure levels, remember that NRRs may be subtracted directly from dB(C) sound pressure levels but an 7 dB must be subtracted from a db(A) sound pressure level before the NRR is subtracted to arrive at the sound pressure level expected at the wearer's ear.

10. **NOISE CONTROL ENGINEERING**.

a. Although noise control engineering is the best means of limiting noise exposure, most workplace noise continues unabated due to limited funds and low priority.

b. Department of Defense risk assessment coding is being used to set priorities for noise control projects at a variety of Navy activities. Most of the projects are new construction or modernization of existing buildings where noise control was factored into the projects.

c. For more information contact:

Commanding Officer
Navy Environmental Health Center
Occupational Medicine Directorate, Occupational Audiology
620 John Paul Jones Circle,
Suite 1100
Portsmouth, VA 23708-2103

11. **CERTIFICATION OF AUDIOMETRIC CHAMBERS.** (Reference 5-6).

a. Audiometric test booths used for air-conduction hearing tests require annual certification by an industrial hygienist, audiologist or industrial hygiene technician. Protocols differ for medical surveillance purposes and for clinical audiometric testing. The requirements in Table 5-1 apply to audiometric test booths used for medical surveillance and physical examinations. The requirements in Table 5-2 are far more stringent and apply to audiometric test booths used for clinical testing in a sound field (ears uncovered). The requirements in Table 5-3 apply to audiometric test booths used for clinical testing using headphones (ears covered) and no sound field. (The clinical audiometric test booth requirements presented in Table 5-3 are less stringent than those presented in Table 5-2). Clinical booths must be certified one octave below the lowest frequency to be tested. For example, record the sound pressure level at 125 hertz (Hz) if the clinician tests at 250 Hz and above. Also, Tables 5-1 through 5-3 assume that the audiologist/examiner is only going to test as low as 0dB hearing level (HL), although audiometers are typically calibrated down to -10dB HL. If testing down to -10dB HL under headphones or with insert earphones (which is frequently the case with children), then ears covered ambient noise levels in the booth must be at least 10dB lower than maximum permissible ambient noise levels (MPANLs).

Table 5-1. Maximum Allowable Sound Pressure Levels (SPLs) in Audiometric Test Booths for Medical Surveillance Hearing Tests

Octave Band Center Frequency (Hz)	500	1000	2000	4000	8000
Maximum SPL (dB)*	27	29	34	39	41

*Reference 5-7

Table 5-2. Maximum Permissible Ambient Noise Levels (MPANLs) Ears Not Covered in Audiometric Test Booths for Clinical Hearing Tests

Octave Band Center Frequency (Hz)	125	250	500	1000	2000	4000	8000
Maximum SPL (dB)*	35.0	21.0	16.0	13.0	14.0	11.0	14.0

*Reference 5-8 (The complete ANSI S3.1-1999 can be ordered on-line at http://www.ansi.org/)

Table 5-3. Maximum Permissible Ambient Noise Levels (MPANLs) Ears Covered in Audiometric Test Booths for Clinical Hearing Tests

Octave Band Center Frequency (Hz)	125	250	500	1000	2000	4000	8000
Maximum SPL (dB)*	39.0	25.0	21.0	26.0	34.0	37.0	37.0

*Reference 5-8 (The complete ANSI S3.1-1999 can be ordered on-line at http://www.ansi.org/)

b. All audiometric booths require, at minimum, annual certification (365 day interval). External and internal conditions that would prevail during normal use should be duplicated at the time of certification. For example, a shipboard booth that has been certified pier-side cannot be utilized underway until it has been evaluated under representative underway conditions. Any significant new noise (inside or outside of the booth) or relocation of the booth requires recertification.

c. At a minimum, a Type I sound level meter with octave band filters is required to measure the sound pressure levels inside the booth during normal operational conditions. The sound level meter must be capable of measuring at least 10 decibels below the values listed in the following tables. The sound level meter, octave band analyzer, microphone, and calibrator must each have been professionally calibrated within one year.

d. Audiometric test booth certifications are valid only when interior ambient noise levels are sufficiently low to comply with the requirements in Tables 5-1, 5-2 or 5-3 above, as appropriate. Audiometric exams, conducted under conditions exceeding the allowable sound pressure levels cited in Tables 5-1, 5-2 or 5-3 above, as appropriate, are invalid.

e. Basic procedures. Steps to take to certify a stationary audiometric test booth are outlined below. These procedures do not apply to Mobile Hearing Conservation and Audiometric Trailers (MOHCAT) and Mobile Hearing Conservation Audiometric Vehicles (MOHCAV), which will be discussed in another section.

(1) Conduct the certification at a time when external noise/activity conditions are representative of anticipated test conditions. That also applies to internal conditions (overhead fan, lights). Document those conditions on the certification form.

(2) Perform pre and post-calibration of the sound level meter. Document make/model and calibration dates on the certification form.

(3) Sit in the patient's chair with sound level meter held away from your body and at head height. Select the desired octave band, dial in slow response, and take the reading. Record the range of values if variable, or the modal value if fairly stable. Record results for each required octave band.

(4) For multiple station booths, check levels at seats closest and furthest from the door, and record the higher of the two sets of values.

(5) Record external levels for information value only. Levels will typically be quite variable, so it may preferable to simply record typical dBA and dBC levels.

(6) At some point during the process, have someone talk outside the booth to see if the booth is certifiable under that

condition. If external conversation precludes valid testing, be sure to annotate that fact on the certification form. This will often be the case with single-wall booths.

(7) Record all values; complete and post the certification on the exterior of the booth or on an adjacent wall. Keep a file copy.

f. MOHCATs and MOHCAVs certification.

(1) MOHCAV or MOHCAT booths require annual certification the same as stationary booths. The certification procedure should take place at the location most often used (the major customer). Realistic external noise/activity should be in effect for an accurate and meaningful certification.

(2) It is typically NOT practical to re-certify mobile booths each time they are moved to a different location. However, readings can be taken at each of the primary customers.

(3) The current model MOHCAVs have a second wall of attenuation in the form of the body of the vehicle that works fairly well. However, cross-traffic, generators, flyovers, and small crafts pier-side all have the potential to invalidate test results. Below are three alternatives to ensure test validity.

(a) Conduct and document booth certification at each prospective test location, under worst-case test conditions. You need not repeat the certification for subsequent deployments to the same location.

(b) Use an ambient noise scanner such as the old Demlar units used in the first generation MOHCATs. These sound an audible alarm and flashing red lights when in-booth noise exceeds pre-set levels. They were not included on current vehicles.

(c) A more readily available option is to do a self-test audiogram at each location prior to seeing patients (assuming the hearing thresholds of the listener are all 0 to 5 dB HL). Make sure the test is taken during representative exterior noise conditions.

g. Troubleshooting.

(1) If a booth will not certify in low frequencies, re-check ambient levels with the fan turned off. If fan noise is determined to be the problem, then initiate repair immediately. Replacement of the fan is typically required, as most of them are sealed units with no first echelon maintenance.

(2) Electrical lighting will occasionally be a source for low frequency noise in the form of 60-cycle hum, with harmonics migrating into the 500 Hz test range. This is fixable. Do not make customers sit in a dark room to take their hearing test. It is unprofessional and encourages napping.

(3) The jack panel is a recurring source for ambient noise interference. Some booths simply pass headphone and handswitch wiring though a hole in the jack panel. Sound attenuating material should be carefully packed around the wiring to seal the opening. The jack panel is also a good place to start when troubleshooting intermittent biological calibration difficulty. Biomedical repair personnel should be contacted to do continuity checks and clean/replace jacks and plugs as needed.

(4) Door seal problems are inevitable after a few years of use. The foam seals harden, wear out, and must be replaced. Often a door is hung improperly to begin with, or develops a problem and must be shimmed carefully. A properly hung door will slowly swing shut by itself. A properly sealed door will offer light resistance to a dollar bill that is pulled through the seal.

(5) If the above actions do not solve the problem, consider removing/relocating external noise sources, relocating your booth, adding vibration dampers aboard ship (no simple task; talk to NAVSEA), or look for a replacement. Life cycle for an audio booth is largely dependent on the number of times it has been moved. More than 2 or 3 take down/reassemble evolutions render most booths not worth the trouble.

(6) In high traffic areas, aviation environments, or aboard ship, plan on a double-wall booth. Remember that even a single-wall one-man booth weighs 1800-2000 pounds, and a double-wall weighs (and costs) twice as much.

(7) Finally, internal noise sources can be as problematic as external noise. Make sure that chairs or stools are sturdy metal types that will not squeak. Curtains between multiple test stations will muffle sound and inhibit distractions. Carpeting or rubber mats further dampen noise.

h. Appendix 5-B provides forms, which should be used to document certification of audiometric test booths.

i. For more information regarding audiometric test booth certification consult the NEHC Field Guide to Audiometric Test Booth Certification.

12. **REFERENCES**.

5-1 OPNAVINST 5100.23 Series, Chapter 8, *Hearing Conservation and Noise Abatement.*

5-2 OPNAVINST 5100.19 Series, Chapter B4, *Hearing Conservation Program.*

5-3 NEHC Technical Manual TM 6260.51.99-1 *Navy Medical Department Hearing Conservation Procedures*. 1999.

5-4 ANSI. *Specifications for Sound Level Meters*. ANSI S1.4-1983 (R1994). New York, NY: American National Standards Institute. 1994.

5-5 ANSI. *Specifications for Personal Noise Dosimeters*. ANSI S1.25-1991. New York, NY: American National Standards Institute. 1991.

5-6 NEHC *Field Guide to Audiometric Test Booth Certification*. 2003.

5-7 DODI 6055.12 Series, *DoD Hearing Conservation Program (HCP)*

5-8 ANSI. *Maximum Permissible Ambient Noise Levels for Audiometric Test Rooms*. ANSI S1.3-1991 (R1999). New York, NY: American National Standards Institute. 1999.

APPENDIX 5-A

NOISE SURVEY AND NOISE DOSIMETRY FORMS

1. **FORMS**. The standard forms to be used when conducting a noise survey or when performing noise dosimetry are listed below. These forms are in Microsoft Word format and require Microsoft Word to be installed on your computer in order to open them. To open each form, click on the hyperlink.

a. Instantaneous Sound Level Surveys. Noise surveys conducted with hand-help sound level meters to document instantaneous sound pressure levels should be documented on an Industrial Hygiene Noise Survey Form - NEHC Form 5100/17.

b. Noise Dosimetry. Noise dosimetry measurements should be documented on an Industrial Hygiene Noise Dosimetry Survey Form - NEHC Form 5100/18.

2. **ASSOCIATED FORMS DEFINITIONS AND EXPLANATIONS**. Definitions and explanations about proper use are provided for the NEHC Forms listed above. These documents are in Adobe Acrobat Reader PDF format and require Adobe Acrobat Reader to be installed on your computer in order to open it. To open the document, click on the hyperlink.

a. Industrial Hygiene Air Sample Survey Form (One Worker, Many Stressors) - Definitions and Explanations for NEHC Form 5100/17

b. Industrial Hygiene Single Stressor Air Sample Survey Form (Many Workers, One Stressor) - Definitions and Explanations for NEHC Form 5100/18

APPENDIX 5-B

AUDIOMETRIC BOOTH CERTIFICATION FORMS

1. **FORMS**. The standard forms to be used when certifying an audiometric booth are listed below. These forms are in Adobe Acrobat Reader PDF format and require Adobe Acrobat Reader to be installed on your computer in order to open them. To open each form, click on the hyperlink.

a. Medical Surveillance Audiometric Booth Certification. Documentation should be performed on Medical Surveillance Booth Certification Form.

b. Clinical Audiometric Booth Certification. Documentation should be performed on Clinical Audiometric Booth "Ears Uncovered" Certification Form or Clinical Audiometric Booth "Ears Covered" Certification Form.